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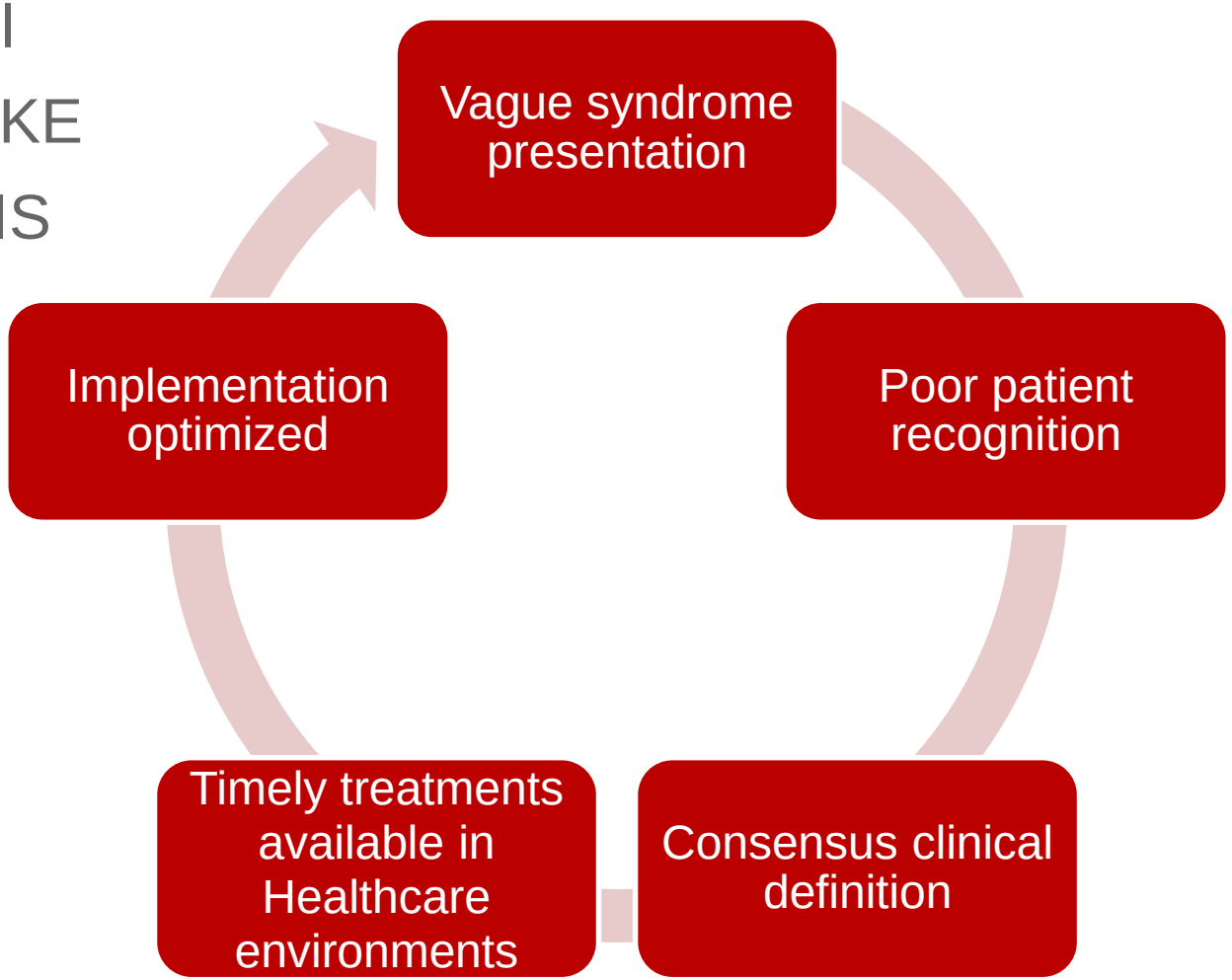
WEXNER MEDICAL CENTER

Early Detection of Sepsis: Back to the basics

Naeem Ali October 14th, 2016

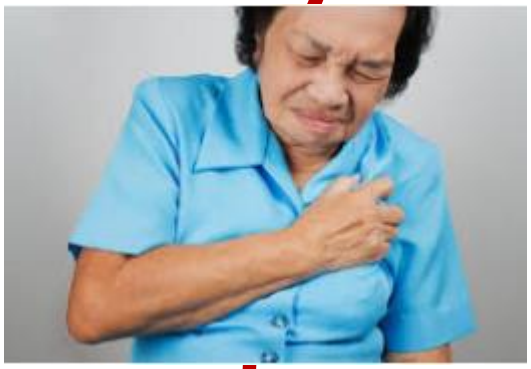
Time Critical Disease

- STEMI
- STROKE
- SEPSIS



Presenting Symptoms

From vague

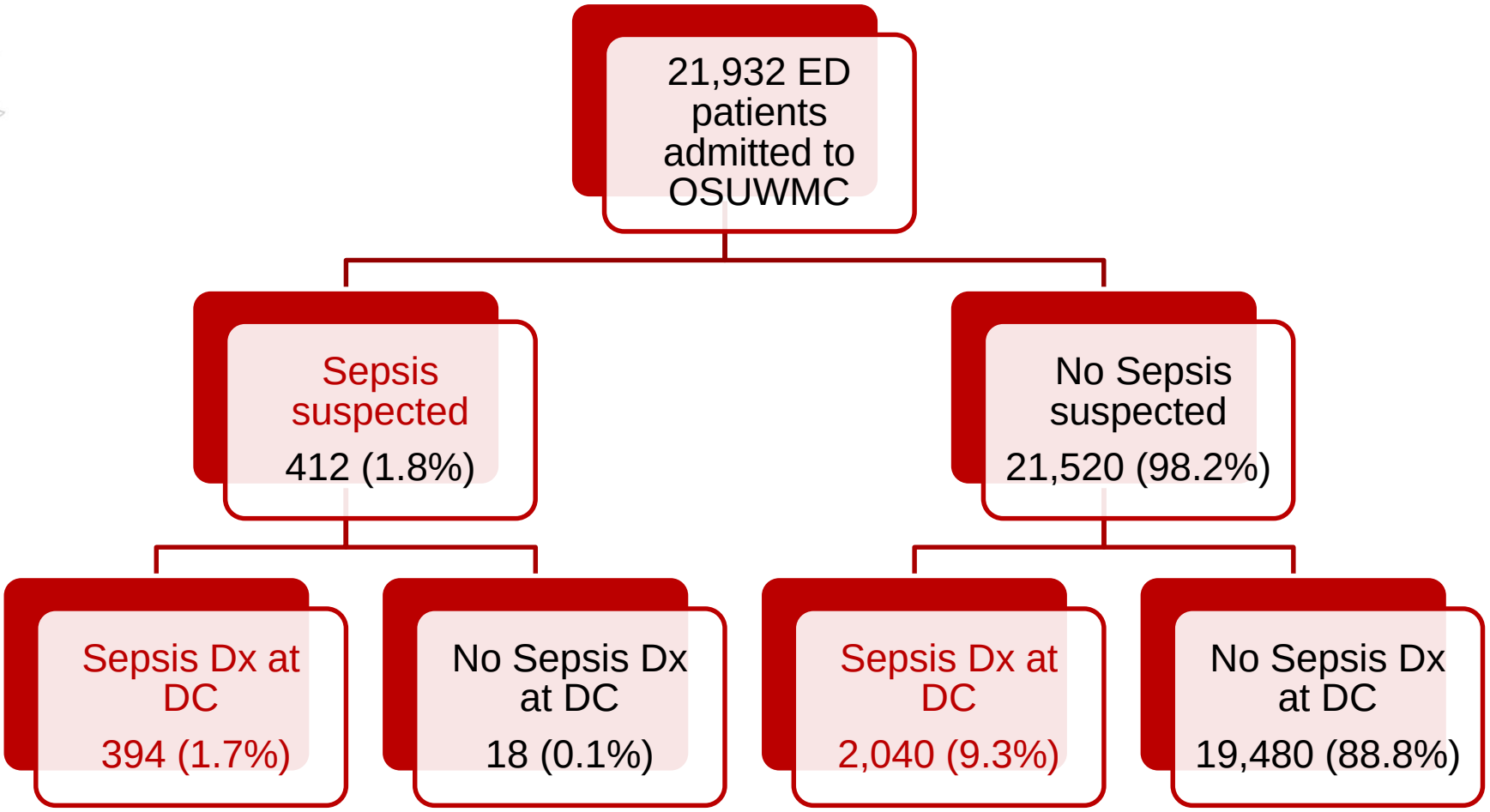


To actionable

Sepsis Definition

1992 Consensus Definitions		SEP-3 Definitions	
Sepsis	*2 of more Systemic Inflammatory Response Syndrome (SIRS) Criteria:* • Temperature > 38 C or < 36 C • Heart Rate > 90 beats/minute • Respiratory Rate > 20 breaths/minute • White Blood Cell count > 12,000 cells/mL^3	**Sepsis**	*2 or more qSOFA criteria:* • Respiratory Rate > 20breaths/minute • Systolic Blood Pressure < 100mmHg • Altered Mental Status
Severe Sepsis	*Sepsis + Evidence of organ dysfunction:* • Neurologic: Altered Mental Status by historyor exam • Cardiovascular: SBP < 90 mmHg after fluidchallenge • Metabolic: Lactate > 4.0 mmol/L • Hematologic: Platelets < 100,000 cells/mL^3 • Renal: Creatinine > 2.0 mg/dL, not known tobe chronic • Pulmonary: Respiratory rate > 20 breaths/minute or Pulse oximetry < 90% on room air or < 95% while breathing supplemental oxygen >4 L/min		
Septic Shock	*Sepsis + Evidence of hypoperfusion:* • Vasopressor Requirement • Hypotension after at least 2 L intravenous fluids	**Septic shock**	*Vasopressor requirement to maintain MAP > 65 and serum lactate > 2.0 mmol/L*

“Hidden Sepsis” is common in patients being admitted from the ED



Only 394 of 2,434 patients (16.2%) with a final Dx of Sepsis were obvious at presentation

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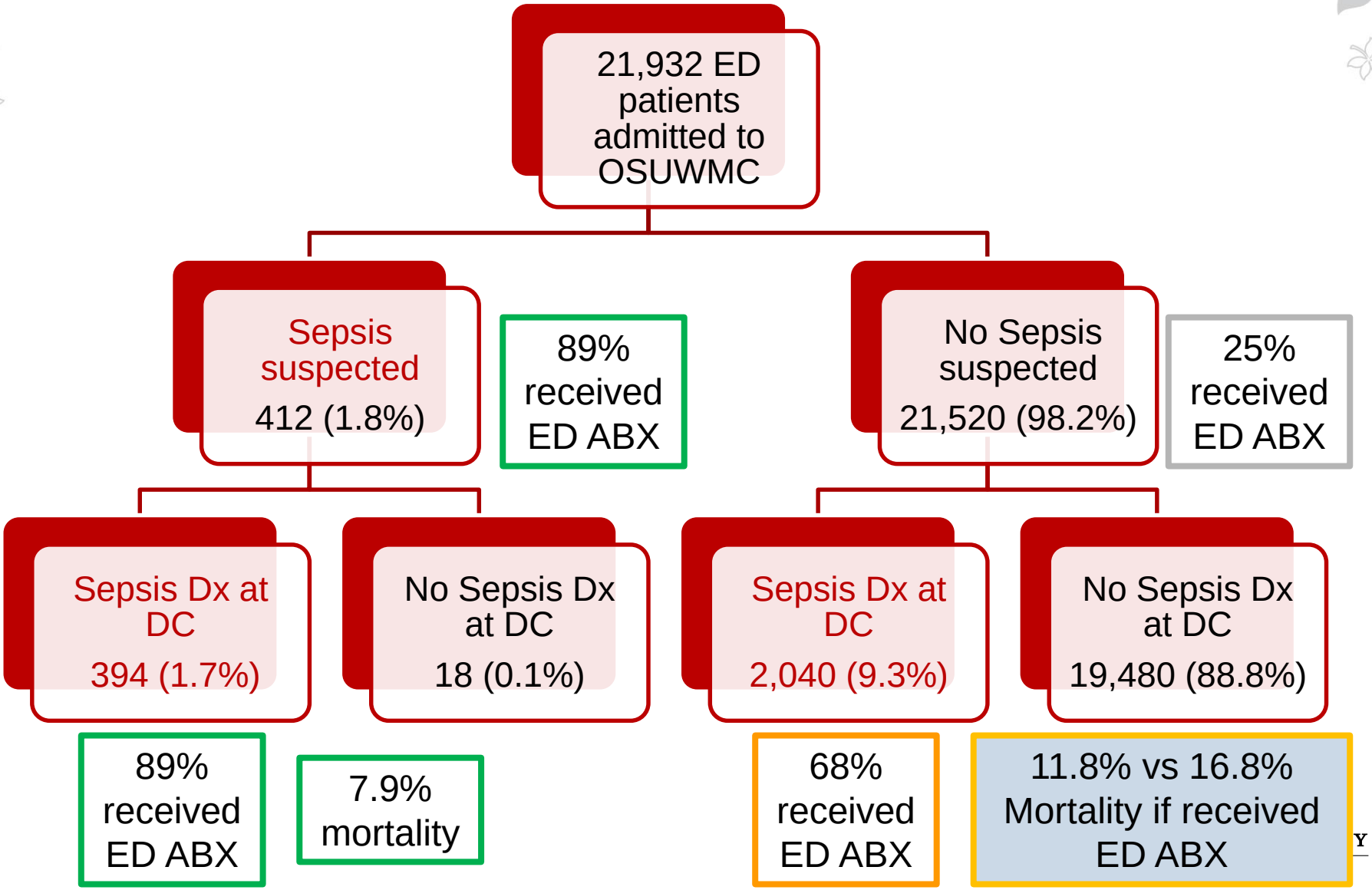
“Hidden Sepsis” is common in patients being admitted from the ED CY2014

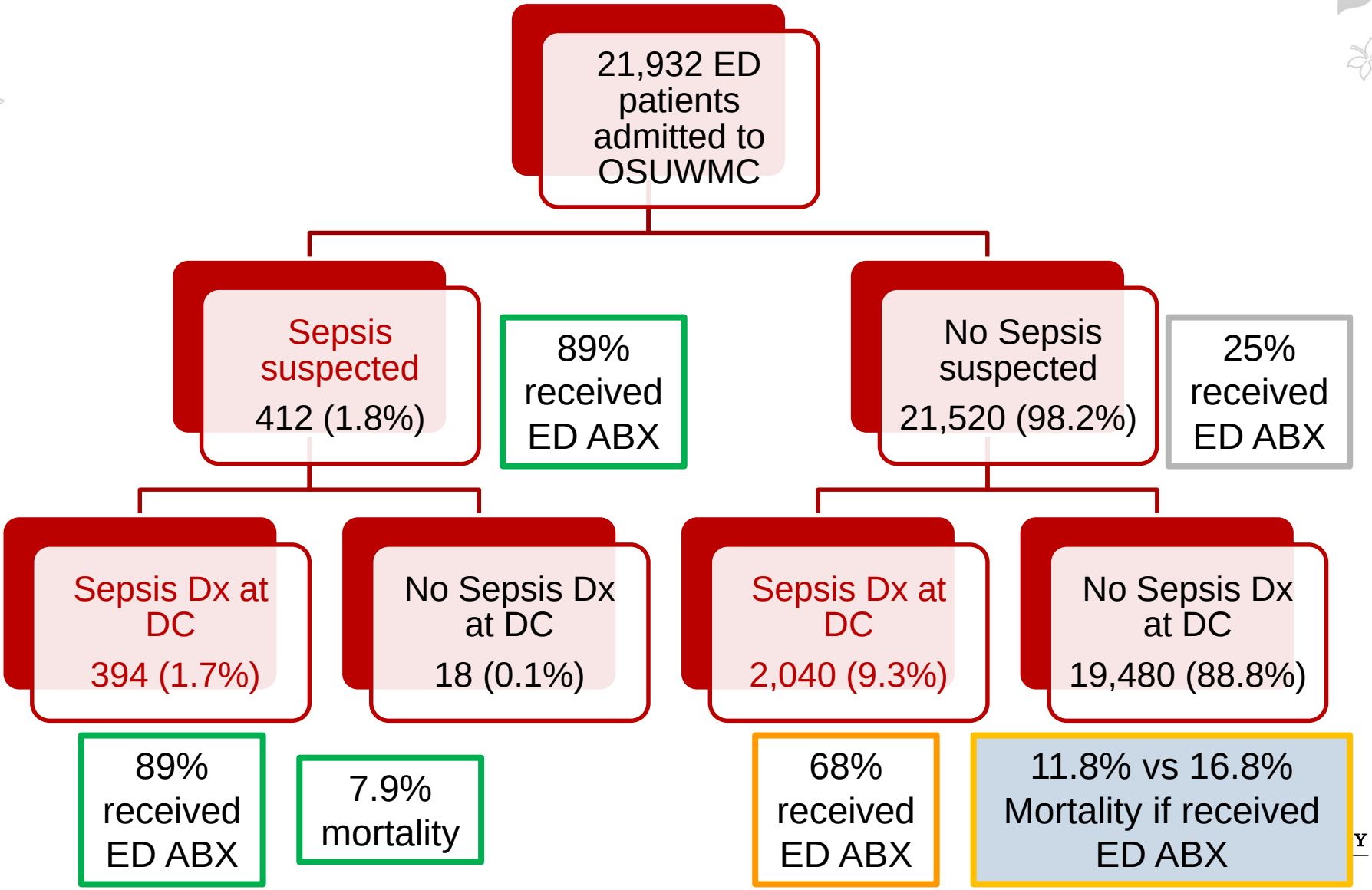


Why is Sepsis such a problem in hospitals?

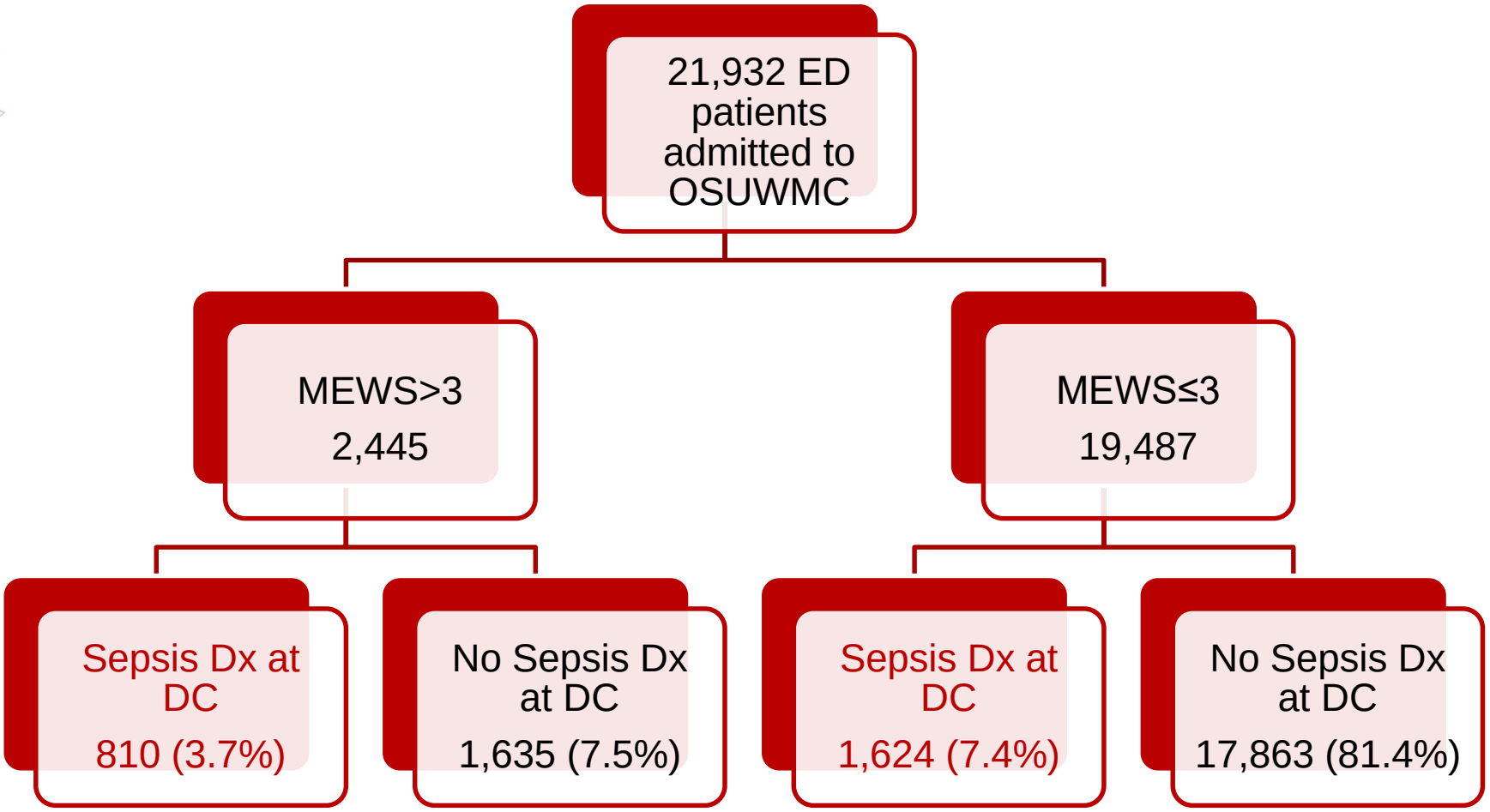
	Out-of-hospital	In-Hospital	Annual cases	
STEMI	95%	~5%	790,000	• Dai X, et al, *Interv Cardiol Clin.* 2016 Oct;5(4):471-480. • Kimura, K ,et al. Eur Neurol 2006; 55: 155–9 • Kumbler E, et al Stroke. 2014;45:231-238 • DB Paige, et al, *Crit Care Med*, 2015; 43:1945-1951.
• *Mortality*	*10.3%*	*27.6%*		
Stroke	95%	~5%	795,000	
• *Mortality*	*13%*	*35%*		
Sepsis	89%	11%	1,500,000	
• *Mortality*	*16.2%*	*31.0%*		

- In-hospital recognition is necessary twice as frequently for SEPSIS than other time critical diseases.
- In-hospital occurrence of SEPSIS is four times prevalent than for STEMI or STROKE

“Hidden Sepsis” is common in patients being admitted from the ED CY2014



“Hidden Sepsis” is common in patients admitted from the ED



810 of 2,434 patients (33.2%) with a final Dx of Sepsis were recognizable with a MEWS score

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What diseases are prevalent in MET calls?

Table 2 Characteristics and outcomes of patients who received a timely or a delayed MET call

Variable	Timely MET call	Delayed MET call	*P*
Female sex	53 (47.7%)	39 (43.8%)	.31
Medical case	67 (60.4%)	65 (73%)	.06
APACHE II	20 (18%)	14 (15.7%)	.66
comorbidities			
For full resuscitation	97 (87.3%)	85 (95.5%)	.50
CCF	24 (21.6%)	9 (10.1%)	.03
DM	14 (12.6%)	8 (8.9%)	.55
Sepsis	61 (54.9%)	56 (62.9%)	.25
Made NFR after call	15 (13.5%)	24 (26.9%)	.017
Admitted to ICU	41 (36.9%)	47 (52.8%)	.122
Endotracheal intubation	20 (18%)	17 (19.1%)	.84
Died	28 (25.2%)	44 (49.4%)	.002

Prospective study of MET calls

JL Quach, "Characteristics and outcomes of patients receiving a medical emergency team review for respiratory distress or hypotension." 2008 *J of Crit Care*

Medical Deterioration?

- Unexpected clinical worsening due to natural history of a disease…

  or

  …the unanticipated new ailment
- Current standard is to identify patients based on surveillance for physiologic change (single, combination, manual, automated, integrated…)

Interpreting clinical signs

Involves medical history

Current appearance

Current physiology

Physiologic trajectory (perspective)

Diagnostic considerations (knowledge dependent)

Monitoring dependent

Experience dependent

Medical Emergency Teams

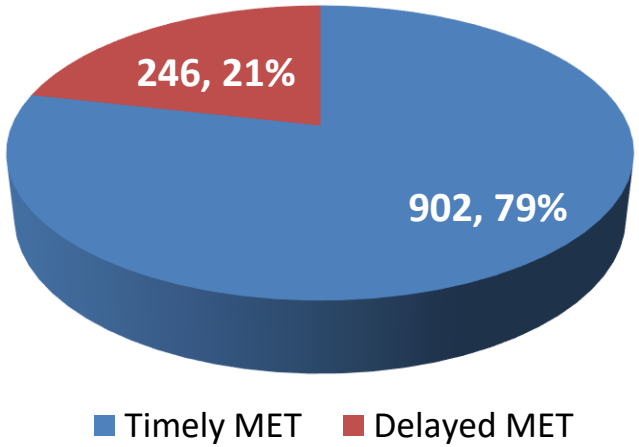
- *Systems* of VS surveillance have improved the ability to recognize deterioration

  Some events are still missed…

  I don't have the fancy monitors that alert me…

What happens when MET call is delayed?

- Review of 18 months of MET calls
  - 1,148 MET calls
  - Deemed late if criteria existed for longer than 30 mins before Call
  - Study performed more than 2 years after program start



Boniatti CM, *CCM* vol 42, no1 2014

What happens when MET call is delayed?

- Review of 18 months of MET calls
  - 1,148 MET calls; 21% delayed

	Delayed	Timely	
Age	61	63	NS
Bedside RN as Caller	*55.3%*	*70.4%*	<0.001
MET criteria • Low SBP • Abnl RR • Abnl SpO2 • Global concern	 • 36% • 25 • 58 • 6.9	 • 15% • 9 • 33 • 37	<0.001

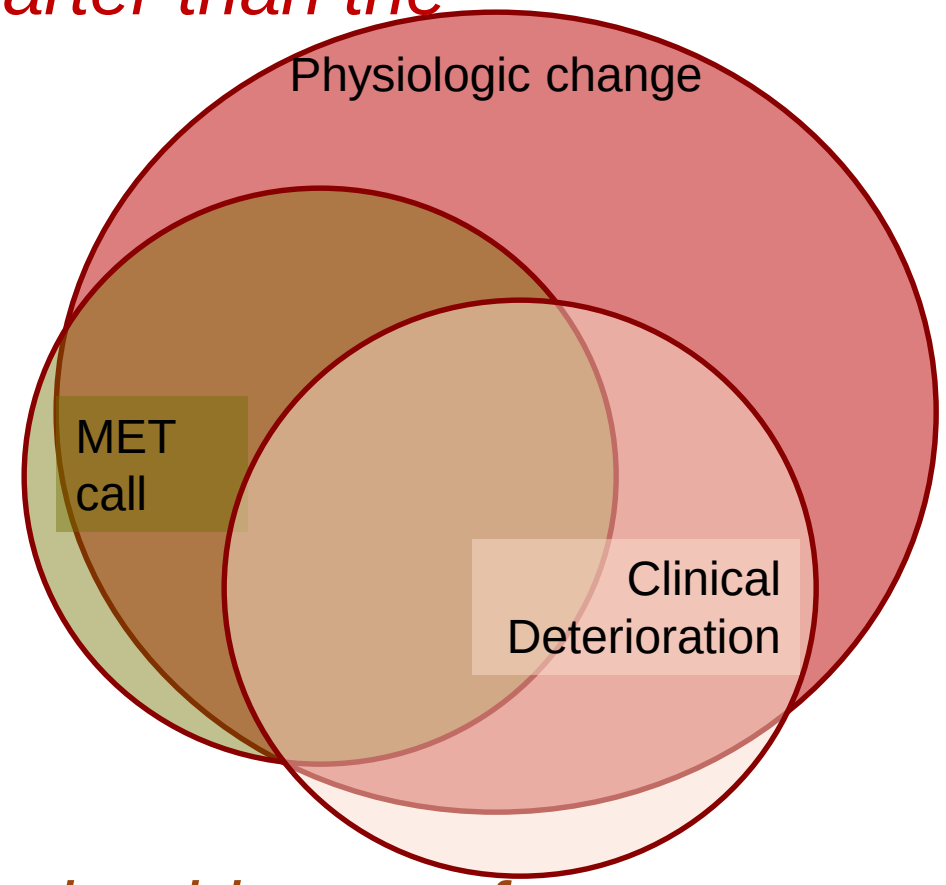
Delayed call: 47%↑odds of 30d mortality

OR 1.47 [1.2-1.8]; adj for gender, GCS, DNR, Medical, criteria#

Boniatti CM, *CCM* vol 42, no1 2014

Monitoring dilemma

How can we be smarter than the "numbers"?



On which patients should we perform targeted assessments?

On which patients should we perform targeted assessments?

- Airway concern
- Seizures
- GCS altered or changed
- RR change
- HR change
- BP concern
- Staff concern

In MERIT, MET hospitals MUCH more likely to activate based on “concern” alone

On which patients should we perform targeted assessments?

- Staff concern
  - Informal Criteria used by teams for informal proactive rounding
    - Change in MEWS
    - Post-op patients
    - New sick admits to floor
    - Post-ICU transfer patients

Transitions of care and physiologic state

We see a LOT of SEPSIS at OSUWMC

- ICU admissions: CY2013-2015Q1-3
  - 22 DRGs represent 70% of ICU patients treated in our ICUs

DRG	Description	Count
871	SEPTICEMIA OR SEVERE SEPSIS W/O MV 96+ HOURS W MCC	1408
25	CRANIOTOMY & ENDOVASCULAR INTRACRANIAL PROCEDURES W MCC	899
208	RESPIRATORY SYSTEM DIAGNOSIS W VENTILATOR SUPPORT <96 HOURS	597
3	ECMO OR TRACH W MV 96+ HRS OR PDX EXC FACE, MOUTH & NECK W MAJ O.R.	568
870	SEPTICEMIA OR SEVERE SEPSIS W MV 96+ HOURS	557
853	INFECTIOUS & PARASITIC DISEASES W O.R. PROCEDURE W MCC	552
4	TRACH W MV 96+ HRS OR PDX EXC FACE, MOUTH & NECK W/O MAJ O.R.	398
64	INTRACRANIAL HEMORRHAGE OR CEREBRAL INFARCTION W MCC	350
207	RESPIRATORY SYSTEM DIAGNOSIS W VENTILATOR SUPPORT 96+ HOURS	287
329	MAJOR SMALL & LARGE BOWEL PROCEDURES W MCC	271
917	POISONING & TOXIC EFFECTS OF DRUGS W MCC	216
314	OTHER CIRCULATORY SYSTEM DIAGNOSES W MCC	189
23	CRANIO W MAJOR DEV IMPL/ACUTE COMPLEX CNS PDX W MCC OR CHEMO IMPLANT	183
981	EXTENSIVE O.R. PROCEDURE UNRELATED TO PRINCIPAL DIAGNOSIS W MCC	161
441	DISORDERS OF LIVER EXCEPT MALIG,CIRR,ALC HEPA W MCC	152
377	G.I. HEMORRHAGE W MCC	143
326	STOMACH, ESOPHAGEAL & DUODENAL PROC W MCC	141
166	OTHER RESP SYSTEM O.R. PROCEDURES W MCC	109
957	OTHER O.R. PROCEDURES FOR MULTIPLE SIGNIFICANT TRAUMA W MCC	99
20	INTRACRANIAL VASCULAR PROCEDURES W PDX HEMORRHAGE W MCC	96
405	PANCREAS, LIVER & SHUNT PROCEDURES W MCC	73
456	SPINAL FUS EXC CERV W SPINAL CURV/MALIG/INFEC OR 9+ FUS W MCC	57

Code Blue ERT FY13 Goals

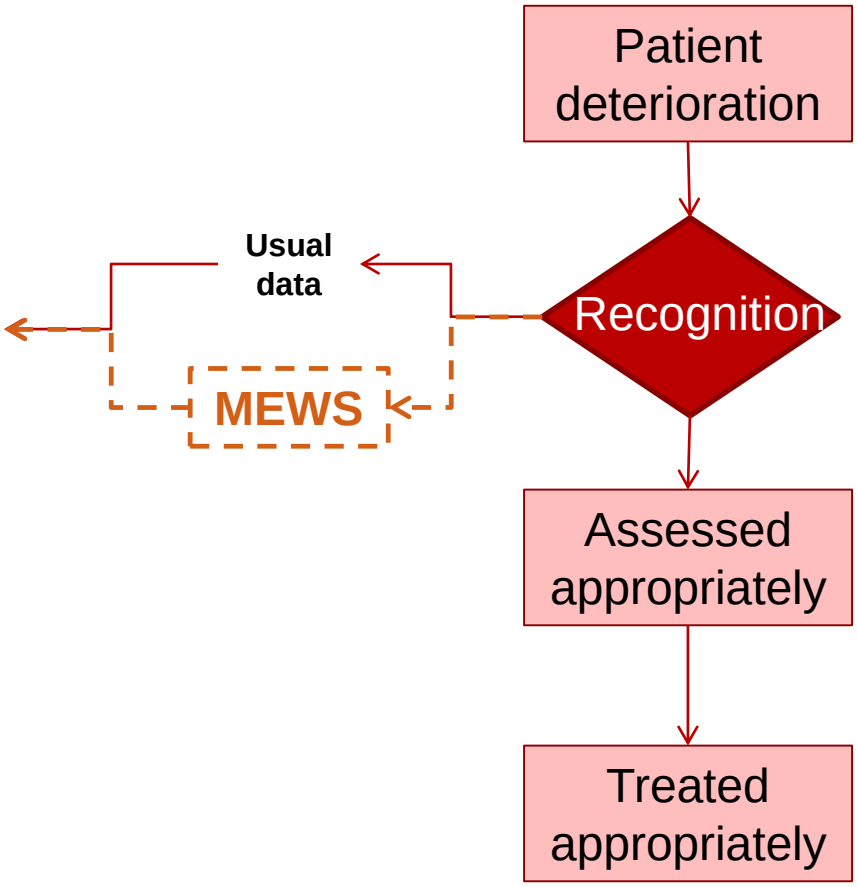
Goal	Metric
1. Defibrillate all patients with initial rhythms of Vfib / pulseless VTach ≤ 2 minutes	• Time to defibrillation in eligible patients (goal 85%)
2. Improve early recognition of deteriorating patients	• Implementation of Modified Early Warning Score (MEWS) into clinical practice • Collaborate with Neurology to finalize the procedure for inpatient stroke code screening • Revise ERT policy to include MEWS and stroke screening process
3. Improve efficiency and functioning of the Code Blue Teams	• 85% compliance MD code note documentation • 50% physician-led team debriefing for true code events

Goal #2: Improve early recognition of deteriorating patients

Primary physician
- Overall trajectory
- Global treatment plan

Bedside RN
- Short-term trajectory
- Immediate treatment plan
- Immediate safety

ERT RN
- General CC skills
- Recognition of emerging Critical Illness
- *Standardized assessments/screening*



Goal #2: Improve early recognition of deteriorating patients

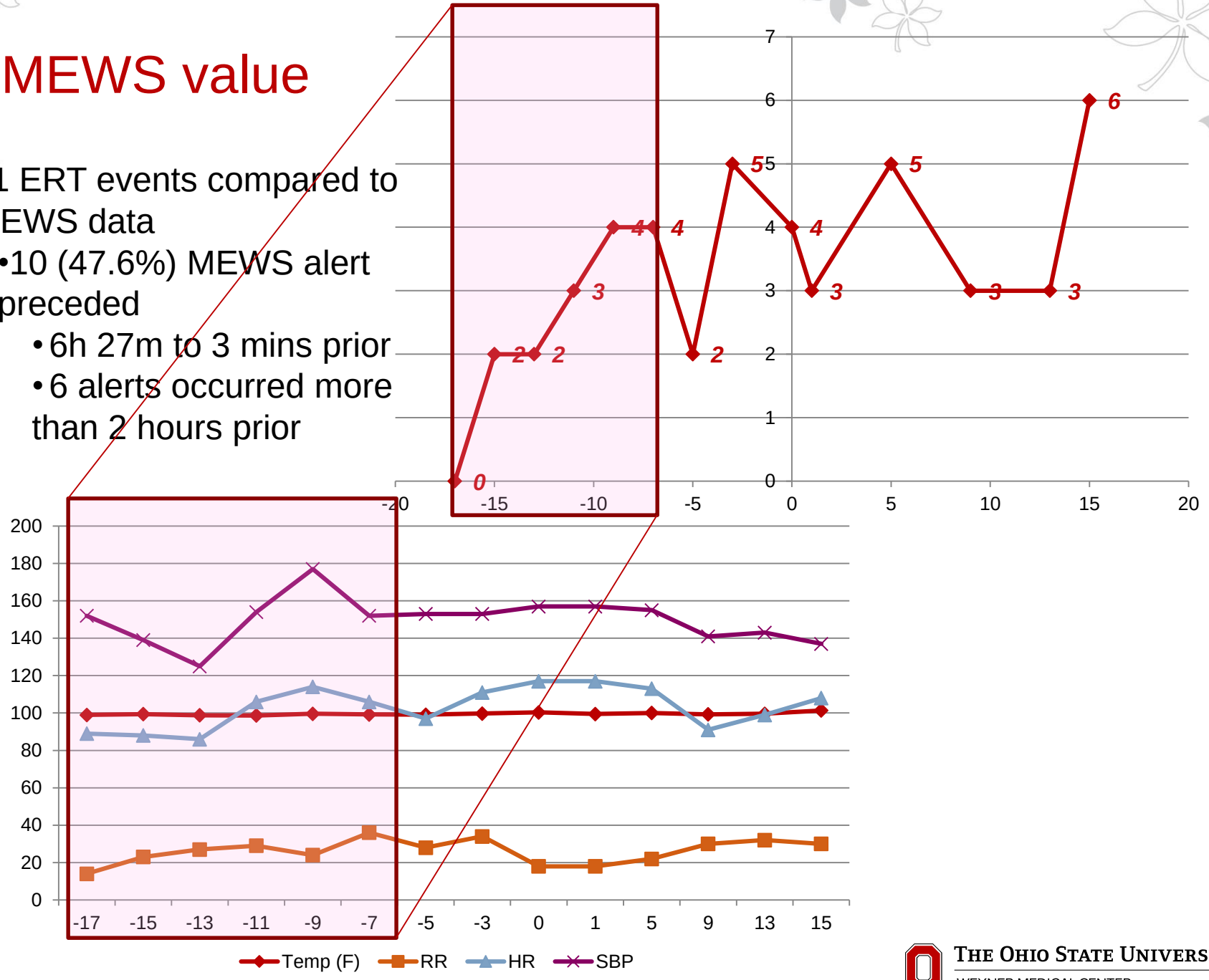
- Implementation of Modified Early Warning Score (MEWS) into Clinical Practice
  - "Synthetic" measure of severity of illness

	3	2	1	0	1	2	3
SBP (mm Hg)	< 70	71 - 80	81 - 100	101 - 199		≥ 200	
Pulse rate (bpm)		< 40	41 - 50	51 - 100	101 - 110	111 - 129	≥ 130
Respiratory rate (bpm)		< 9		9-14	15 - 20	21 - 29	≥30
Temperature (C)		< 95°		95° - 101°		≥ 101.3°	
AVPU score				Alert	Reacting to voice	Reacting to Pain	Unresponsive

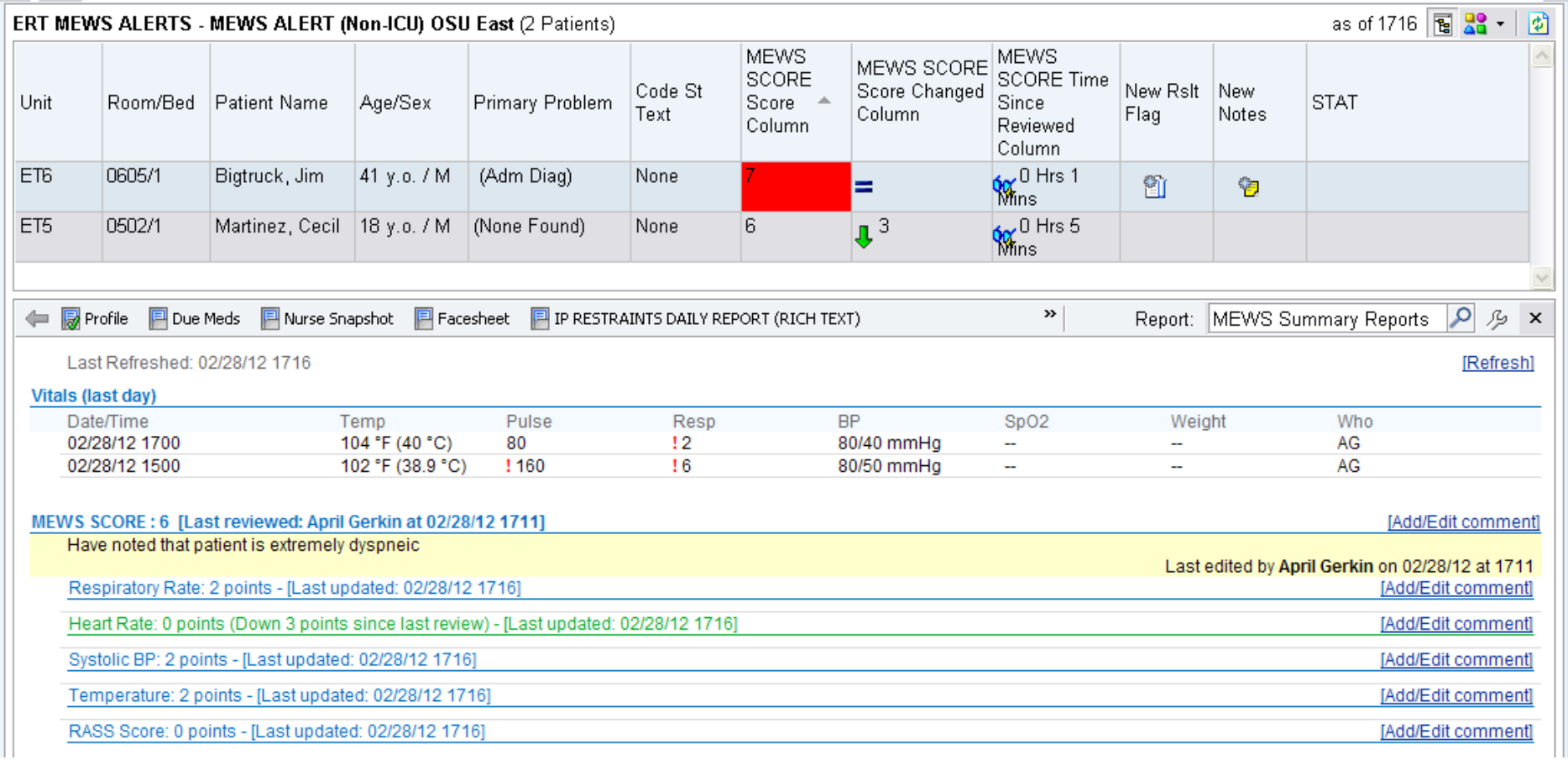
MEWS value

21 ERT events compared to MEWS data

- 10 (47.6%) MEWS alert preceded
  - 6h 27m to 3 mins prior
  - 6 alerts occurred more than 2 hours prior



MEWS Process Change



ERT MEWS ALERTS - MEWS ALERT (Non-ICU) OSU East (2 Patients) — as of 1716

Unit	Room/Bed	Patient Name	Age/Sex	Primary Problem	Code St Text	MEWS SCORE Score Column	MEWS SCORE Score Changed Column	MEWS SCORE Time Since Reviewed Column	New Rslt Flag	New Notes	STAT
ET6	0605/1	Bigtruck, Jim	41 y.o. / M	(Adm Diag)	None	7	=	0 Hrs 1 Mins			
ET5	0502/1	Martinez, Cecil	18 y.o. / M	(None Found)	None	6	↓ 3	0 Hrs 5 Mins			

Profile | Due Meds | Nurse Snapshot | Facesheet | IP RESTRAINTS DAILY REPORT (RICH TEXT) » | Report: MEWS Summary Reports

Last Refreshed: 02/28/12 1716 [Refresh]

Vitals (last day)

Date/Time	Temp	Pulse	Resp	BP	SpO2	Weight	Who
02/28/12 1700	104 °F (40 °C)	80	! 2	80/40 mmHg	--	--	AG
02/28/12 1500	102 °F (38.9 °C)	! 160	! 6	80/50 mmHg	--	--	AG

MEWS SCORE : 6 [Last reviewed: April Gerkin at 02/28/12 1711] [Add/Edit comment]

Have noted that patient is extremely dyspneic

Last edited by **April Gerkin** on 02/28/12 at 1711

Respiratory Rate: 2 points - [Last updated: 02/28/12 1716] [Add/Edit comment]

Heart Rate: 0 points (Down 3 points since last review) - [Last updated: 02/28/12 1716] [Add/Edit comment]

Systolic BP: 2 points - [Last updated: 02/28/12 1716] [Add/Edit comment]

Temperature: 2 points - [Last updated: 02/28/12 1716] [Add/Edit comment]

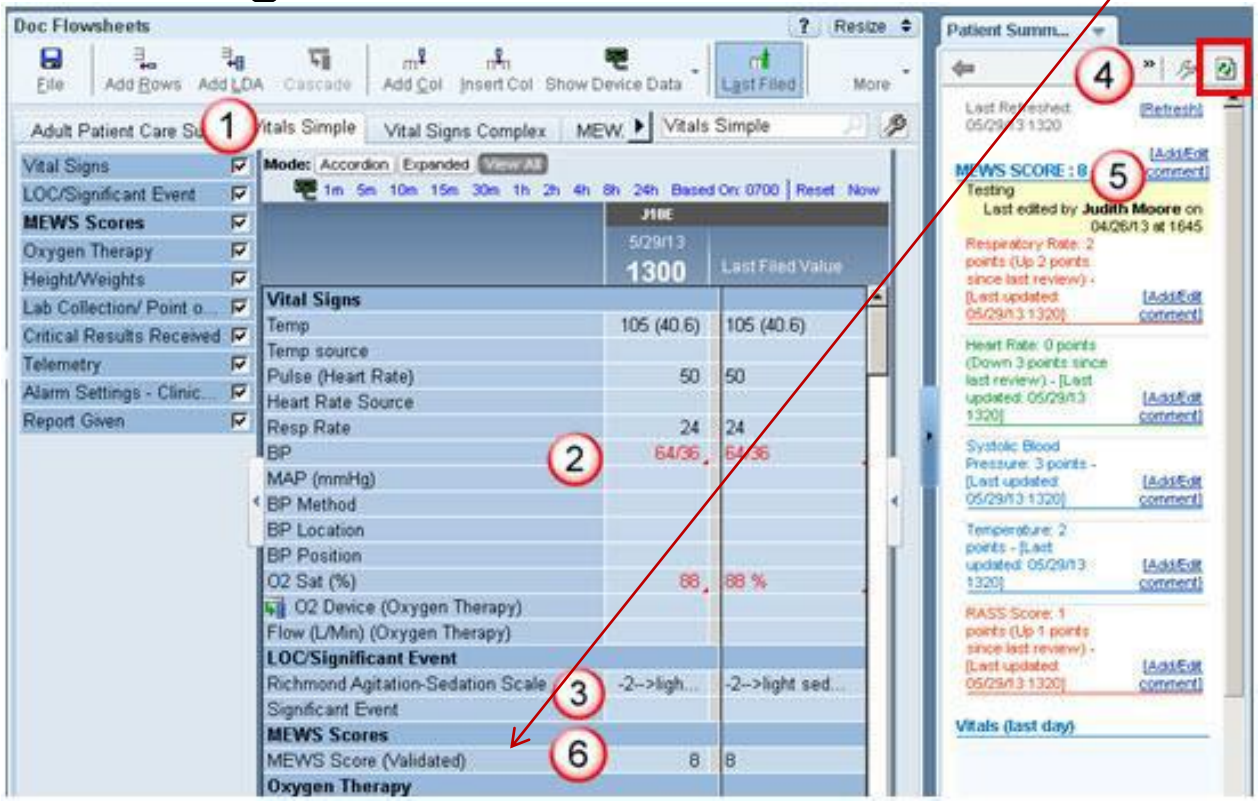
RASS Score: 0 points - [Last updated: 02/28/12 1716] [Add/Edit comment]

System view for RN, Charge RN or STAT team for proactive intervention.
Last fail-safe is addition to ERT policy → ERT call for MEWS>4 or 50% increase

MEWS Update

Staged rollout Feb 18th - May, 2013

- HS Med-Surg & PCU units
  - excluded ED's, ICU's, Harding, Ross: H2, H4, H6
- Scoring in IHIS "live" June 2013

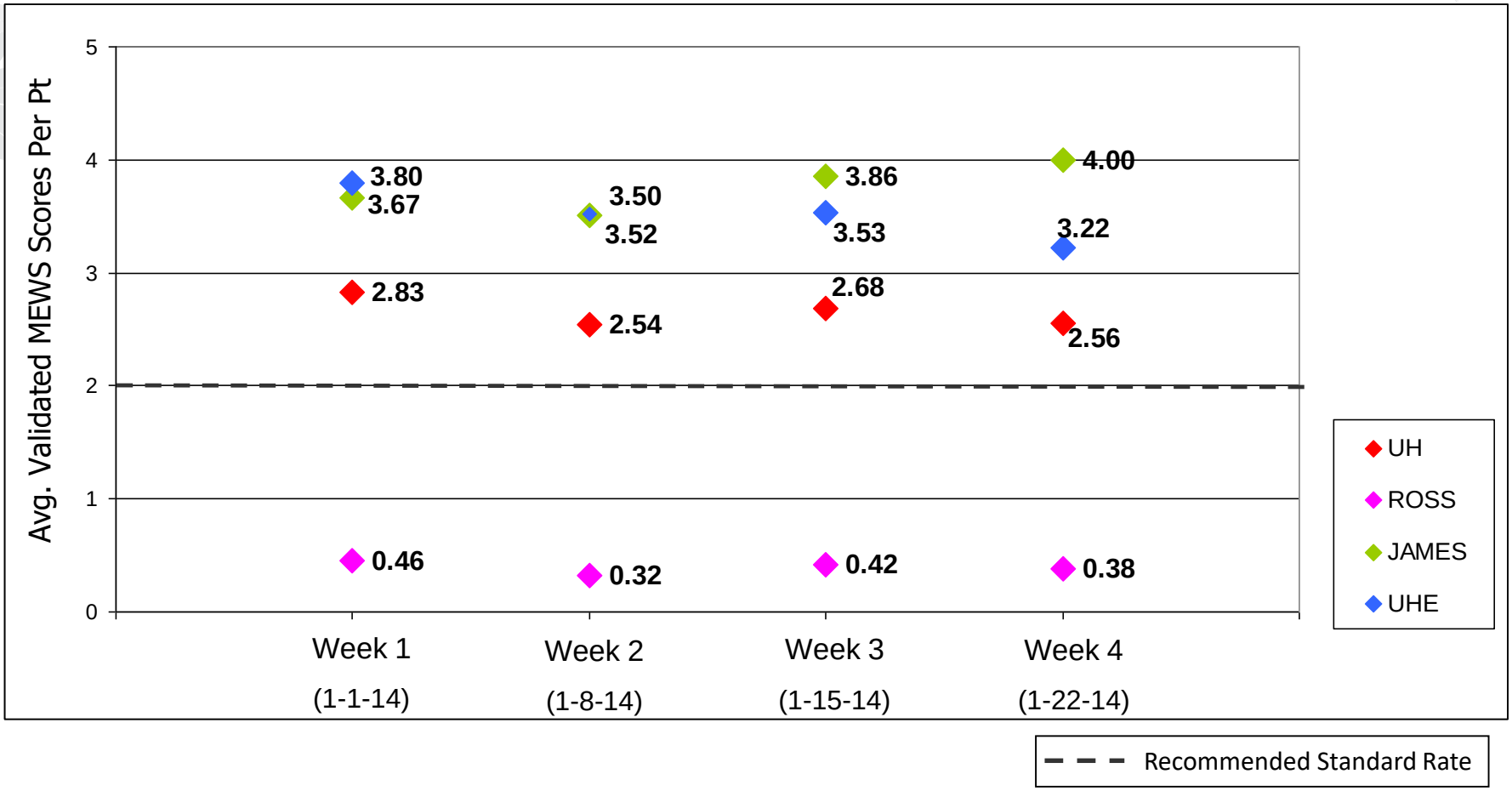


MEWS Validation Report

Revised Validated MEWS Score Report

Census Date	Nursing Unit	Patient in Unit 24H Count	Number of Validated MEWS in 24H Patients	Average MEWS per Patient
2014-01-08	D3	20	20.00	1.00
	D4	26	40.00	1.54
	EN5	14	59.00	4.21
	ET10	15	36.00	2.40
	ET3	17	50.00	2.94
	ET5	11	57.00	5.18
	ET8	13	35.00	2.69
	ETH5	8	38.00	4.75
	EW3	4	14.00	3.50
	H2	16	0.00	0.00
	H5	19	4.00	0.21
	H6	24	0.00	0.00
	H7	16	20.00	1.25
	J10E	18	86.00	4.78
	J10S	8	29.00	3.63
	J7E	12	59.00	4.92
	J7S	11	32.00	2.91
	J8E	14	49.00	3.50
	J8S	13	37.00	2.85
	J9E	9	28.00	3.11
	J9S	14	39.00	2.79
	JBME	12	41.00	3.42
	JBMS	10	27.00	2.70
	JK10	17	62.00	3.65
	JK7C	9	21.00	2.33
	JK9E	16	61.00	3.81

Average Validated MEWS Scores per Patient by Unit



N	Week 1	Week 2	Week 3	Week 4
UH	317	292	294	289
ROSS	83	75	77	85
JAMES	174	163	167	148
UHE	88	82	93	83

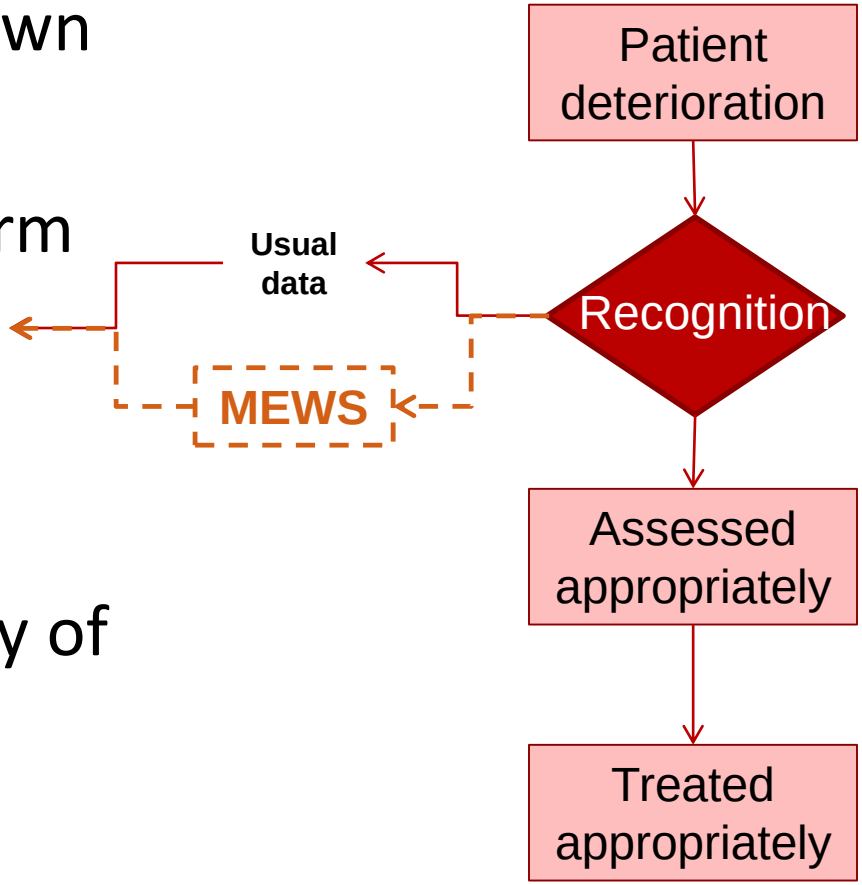
*ROSS does not include H4

ERT activation events

	UH (n=406)	James (n=208)	East (n=154)	Ross (n=148)	Health system (n=916)
CY2012Q2	254	69	129	3	455
CY2012Q3	320	90	96	4	510
CY2012Q4	333	89	101	7	530
CY2013Q1	348	101	116	14	579
CY2013Q2	388	132	118	11	649
CY2013Q3	416	118	159	14	707
Average calls/month	**343.2**	**99.8**	**119.8**	**8.8**	**571.7**
Calls/month/bed	**0.8**	**0.5**	**0.8**	**0.06**	**0.6**

Goal #2: Improve early recognition of deteriorating patients

- Implement MEWS in Progressive Care/Stepdown Units
- ERT call for MEWS>4
  - Modified ERT data form
- 3-4 weeks
  - Register sepsis-related ERT
  - Record treatments
- Goals:
  - Determine the usability of MEWS
  - Validate trigger level
  - Identify barriers to treatment delivery



Goal #2: Improve early recognition of deteriorating patients

Proposed Escalation guidance

		Notify			
MEWS Score	Usual Care	Charge RN	Primary responder	ERT team	Associated care policy
1	x				
2	x				
3	x	x			Consider increased clinical monitoring
4	x	x	x	*Consider*	Consider increased clinical monitoring
5	x	x	x	*Recommend*	Consider increased clinical monitoring
6	x	x	x	*Recommend*	Consider increased clinical monitoring
≥7	x	x	x	*Recommend*	Consider increased clinical monitoring

* Current area of discussion

Goal #2: Improve early recognition of deteriorating patients

Review of prior pilot results

	2010	2011 Pilot	*p-value*
Patients	340	357	
ERT Calls* (%)	13.8%	20.2%	0.026
ERT Calls Requiring Transfer to ICU* (% of cohort)	5.9%	6.4%	0.75
ICU Transfers After PCU Admit#	15.8%	8.4%	0.002
Hospital LOS, Median (IQR)	5 (3-10)	6 (3-10)	0.23

Goal #2: Improve early recognition of deteriorating patients

	2010	2011 Pilot	P-value
Patients	340	357	
Hospital mortality	6.7%	3.9%	0.09
•Sepsis pts	24.6%	13.7%	0.14
•Severe sepsis pts	29.4%	15.6%	0.11
•ERT patients	19.1%	13.9%	0.31

Odds of hospital mortality (OR, 95% CI)

- 0.41 (0.18-0.89), p= 0.025
  - adjusted for # organ failures, age, ERT call
- 0.49 (0.22-1.10), p= 0.086
  - adjusted for # organ failures, age, ERT call and sepsis dx

Conclusions

- MEWS as a “hotspot” indicator appears to identify an important subgroup of patients with sepsis
- A dedicated team was required to understand the process of adding a “synthetic” score into bedside practice (MEWS Workgroup)
  - **Implementation plan is iterative**
    - Appropriate display location for MEWS
    - Operational plans
    - Education plan
  - **MEWS should “trigger” an action, but NOT be automatic**
    - Currently would benefit from clinical overview MEWS + clinical concern ERT call
- MEWS modified patient identification can moderately improve sepsis outcomes
  - Sepsis specific bundles are still required to refine the benefits seen from early detection

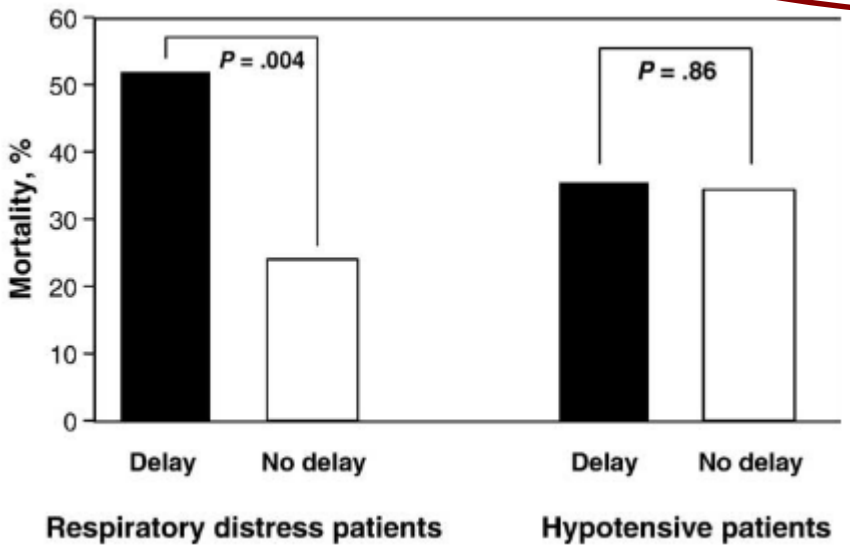
What about the trigger

- Single values
- Multiple values
  - VS only (MEWS)
  - VS plus LAB
  - VS plus LAB/Context
  - Expanded
- Which patients
  - ED
  - Outside of ED

Respiratory symptoms are problematic

Table 1 Common characteristics, underlying comorbidities, and prevalence of delayed MET calls

	Variable	Respiratory distress (N = 100)	Hypotension (N = 100)	*P*
Demographics	Median age (y)	69	72	.78
	Sex (male-female)	52/48	56/44	.57
	Surgery	40	28	.07
	APACHE II comorbidities	11	19	.34
	NFR before MET call	10	8	.62
Patient history	Congestive cardiac failure	12	22	.06
	Severe sepsis	60	56	.57
Outcome	Made NFR after MET call	24	13	.07
	ICU admission within 48 hrs	37	42	.66
	Deceased	38	35	.77
Delayed MET call		50	39	.11
Duration of delay (h)		12 (7-25)	5 (1-24)	.016



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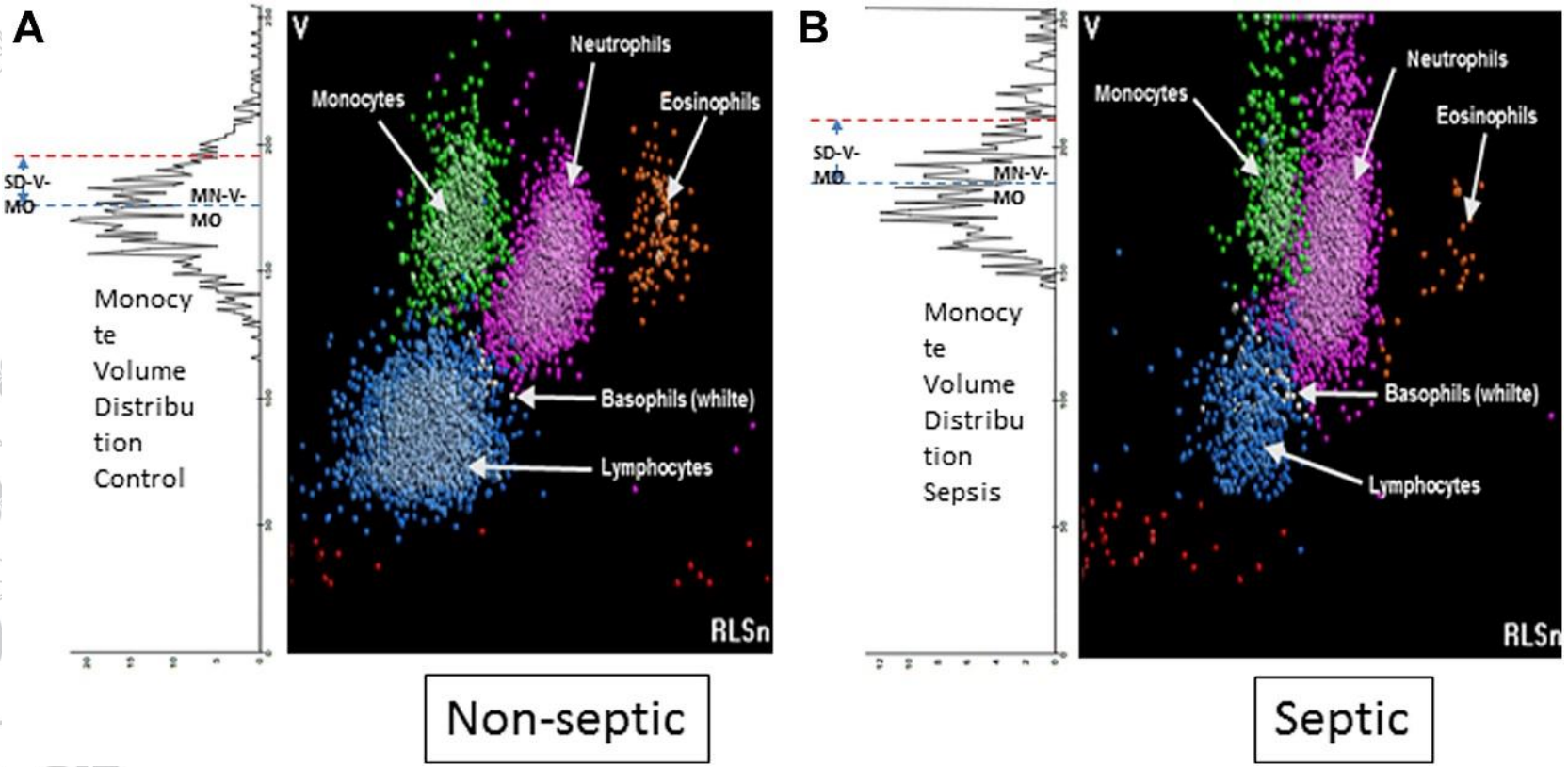
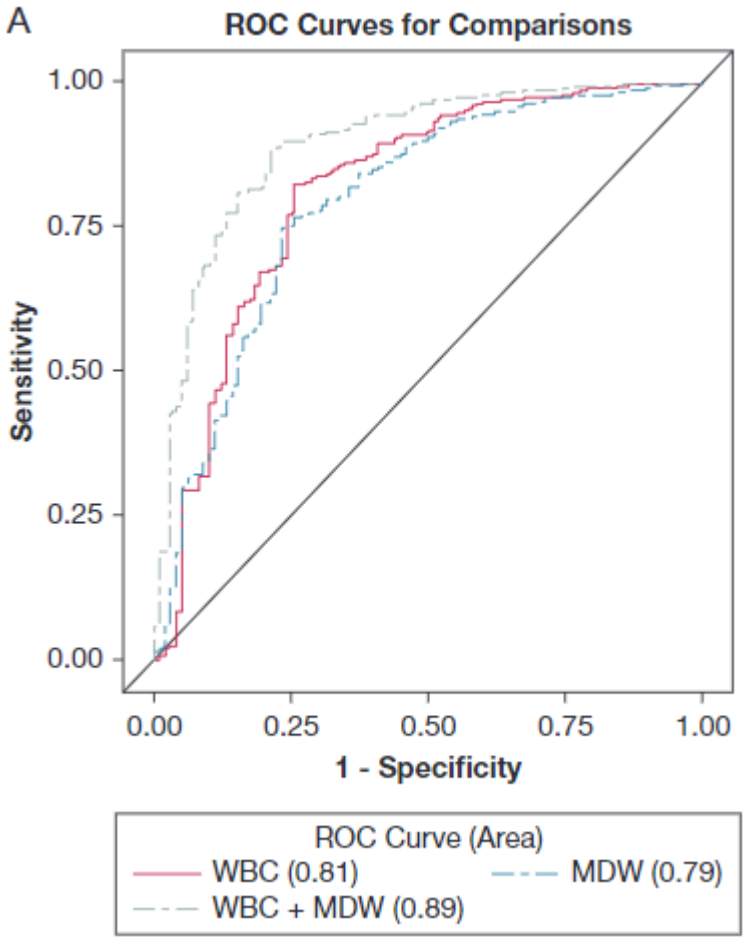
Sepsis detection-Lab triggers



ED Crouser, et al. *Chest*. 2017 Sep;152(3):518-526.

Sepsis detection-Lab triggers



ED Crouser, et al. *Chest*. 2017 Sep;152(3):518-526.

But what else is available for ERT/sepsis triggers?

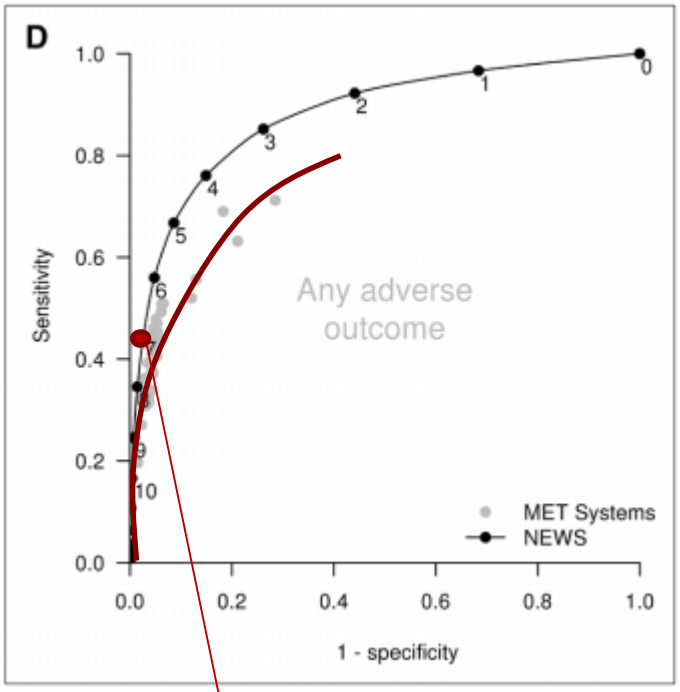
ERT (not Sepsis Specific): Multiple Values single threshold

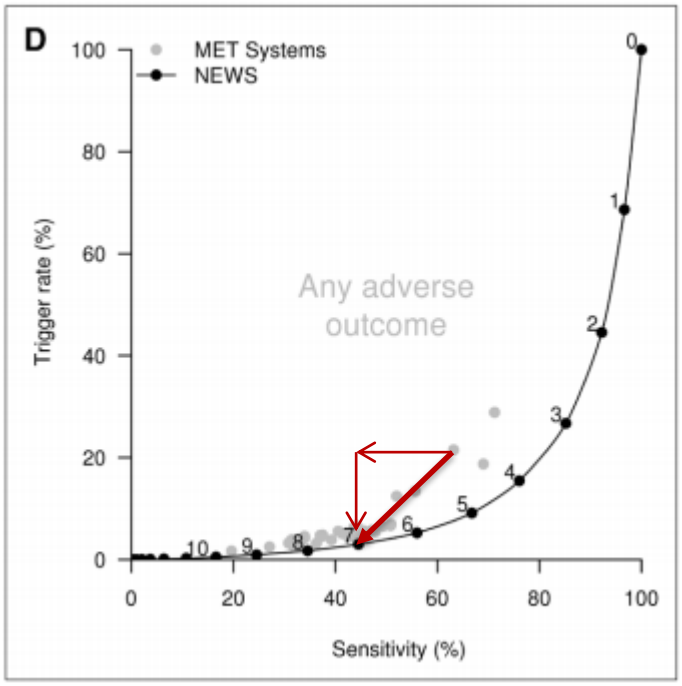
	Pulse rate		Breathing rate		Systolic BP		Temperature		Reduced consciousness	S_pO_2 (%)	F_iO_2	Reference
	beats.m^{-1}		breaths.m^{-1}		mmHg		^oC					
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper				
Bell (MET criteria)	< 40	> 130	< 8	> 30	< 90				*	<90	>0.21	
Bell (Extended)	< 50	> 120	≤ 10	> 28	< 100				*	<90	>0.21	Bell MB, Konrad D, Granath F, Ekbom A, Martling C. Prevalence and sensitivity of MET-criteria in a Scandinavian University Hospital. Resuscitation 2006;70:66-73.
Bell (Restricted)	< 35	> 140	≤ 6	> 32	< 80				*	<90	>0.21	
Ball	< 50	> 125	< 8	> 25	< 90	> 200		> 38.0		<90	>0.35	Ball C. Critical care outreach services--do they make a difference? Intensive Crit Care Nurs 2002;18:257-60.
Parissopoulos	< 45	> 125	< 8	> 25	< 90	> 200			•	<90	>0.21	Parissopoulos S, Kotzabassaki S. Critical care outreach and the use of early warning scoring systems; a literature review. ICUs Nurs Web J 2005;21: 1-11.
Hickey	< 45	> 125	< 8	> 30	< 90				•	<90	≥0.24	Hickey C, Allen M. A critical care liaison service. British Journal of Anaesthesia 1998;81:650.
Salamonson	< 40	> 140	< 6	> 36	< 90				•	<85	≥0.21	Salamonson Y, Kariyawasam A, van Heere B, O'Connor C. The evolutionary process of Medical Emergency Team (MET) implementation: reduction in unanticipated ICU transfers. Resuscitation 2001;49:135-41.
Buist		> 130	< 6	> 30	< 90				•	<90	>0.21	Buist MD, Moore GE, Bernard SA, Waxman BP, Anderson JN, Nguyen TV Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study. BMJ 2002;324:387-90.
Bellomo	< 40	> 130	< 8	> 30	< 90				•	<90	>0.21	Bellomo R, Goldsmith D, Uchino S et al. A prospective before-and-after trial of a medical emergency team. Med J Aust 2003;179:283-7.
Jones	< 40	> 130	< 8	> 30	< 90				•	<90	≥0.21	Jones D, Bates S, Warrillow S et al. Circadian pattern of activation of the medical emergency team in a teaching hospital. Crit Care 2005;9:R303-306.
Green	< 40	> 120	< 5	> 30	< 90				•	<90	>0.21	Green AL, Williams A. An evaluation of an early warning clinical marker referral tool. Intensive Crit Care Nurs 2006;22:274-82.
Harrison (Early)	< 50	> 120	< 10	> 30	< 100	> 180			•	<95	≥0.21	Harrison GA, Jacques TC, Kilborn G, McLaws M. The prevalence of recordings of the signs of critical conditions and emergency responses in hospital wards--the SOCCER study. Resuscitation 2005;65:149-57.
Harrison (Late)	< 40	> 140	< 5	> 40	< 80	> 240			•	<90	≥0.21	
Smith		≥ 100		≥ 25	≤ 95	≥ 200	≤ 35.0	≥ 38.0	•			Smith AF, Wood J. Can some in-hospital cardio-respiratory arrests be prevented? A prospective survey. Resuscitation 1998;37:133-7.
Lee	< 40	> 120	< 10	> 30	< 100	> 200	< 35.5	> 39.5	•			Lee A, Bishop G, Hillman KM, Daffurn K. The Medical Emergency Team. Anaesth Intensive Care 1995;23:183-6.
Parr	< 40	> 140	< 5	> 35	< 90				•			Parr MJ, Hadfield JH, Flabouris A, Bishop G, Hillman K. The Medical Emergency Team: 12 month analysis of reasons for activation, immediate outcome and not-for-resuscitation orders. Resuscitation 2001;50:39-44.
Cretikos original		> 140		> 36	< 90				•			
Cretikos set 1		≥ 120		≥ 25	≤ 90				•			
Cretikos set 2		≥ 125		≥ 25	≤ 90				•			
Cretikos set 3		≥ 120		≥ 25	≤ 85				•			
Cretikos set 4		≥ 125		≥ 25	≤ 85				•			
Cretikos set 5		≥ 130		≥ 25	≤ 85				•			Cretikos, M., Chen, J., Hillman, K, et al. A. The objective medical emergency team activation criteria: a case-control study. Resuscitation 2007; 73:62-72.
Cretikos set 6		≥ 140		≥ 25	≤ 85				•			
Cretikos set 7		≥ 140		≥ 26	≤ 85				•			
Cretikos set 8		≥ 140		≥ 28	≤ 85				•			
Cretikos set 9		≥ 140		≥ 28	≤ 80				•			
Cretikos set 10		≥ 140		≥ 30	≤ 80				•			

Crit Care Med 2016; 44:2171-2181

But what else is available for ERT/sepsis triggers?

ERT (not Sepsis Specific)





Sensitivity: 45%
Specificity: 95%

What is your organizations trigger rate tolerance?

Crit Care Med 2016; 44:2171-2181

But what else is available for ERT/sepsis triggers?

Sepsis Specific-Machine Learning integration modelling

High-resolution dynamical features (calculated using 6 hours sliding windows, with 5 hours overlap; 6 features): standard deviation of RR intervals and MAP (RRSTD and MAPSTD), average multiscale entropy 1 of RR and MAP (HRV1 and BPV1) and average multiscale conditional entropy of RR and MAP (HRV2 and BPV2).

Clinical features (10 features): Mean Arterial Blood Pressure (MAP), Heart Rate (HR), Oxygen Saturation (O2Sat), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Respiratory Rate (RESP), Temperature (Temp), Glasgow Coma Scale (GCS), Partial Pressure of Arterial Oxygen (PaO2), Fraction of Inspired O2 (FIO2).

Laboratory (General; 25 features): White Blood Count (WBC), Hemoglobin, Hematocrit, Creatinine, Bilirubin and Bilirubin direct, Platelets, International Normalized Ratio (INR), Partial Prothrombin Time (PTT), Aspartate Aminotransferase (AST), Alkaline Phosphatase, Lactate, Glucose, Potassium, Calcium, blood urea nitrogen (BUN), Phosphorus, Magnesium, Chloride, B-type Natriuretic Peptide (BNP), Troponin, Fibrinogen, CRP, Sedimentation Rate, Ammonia.

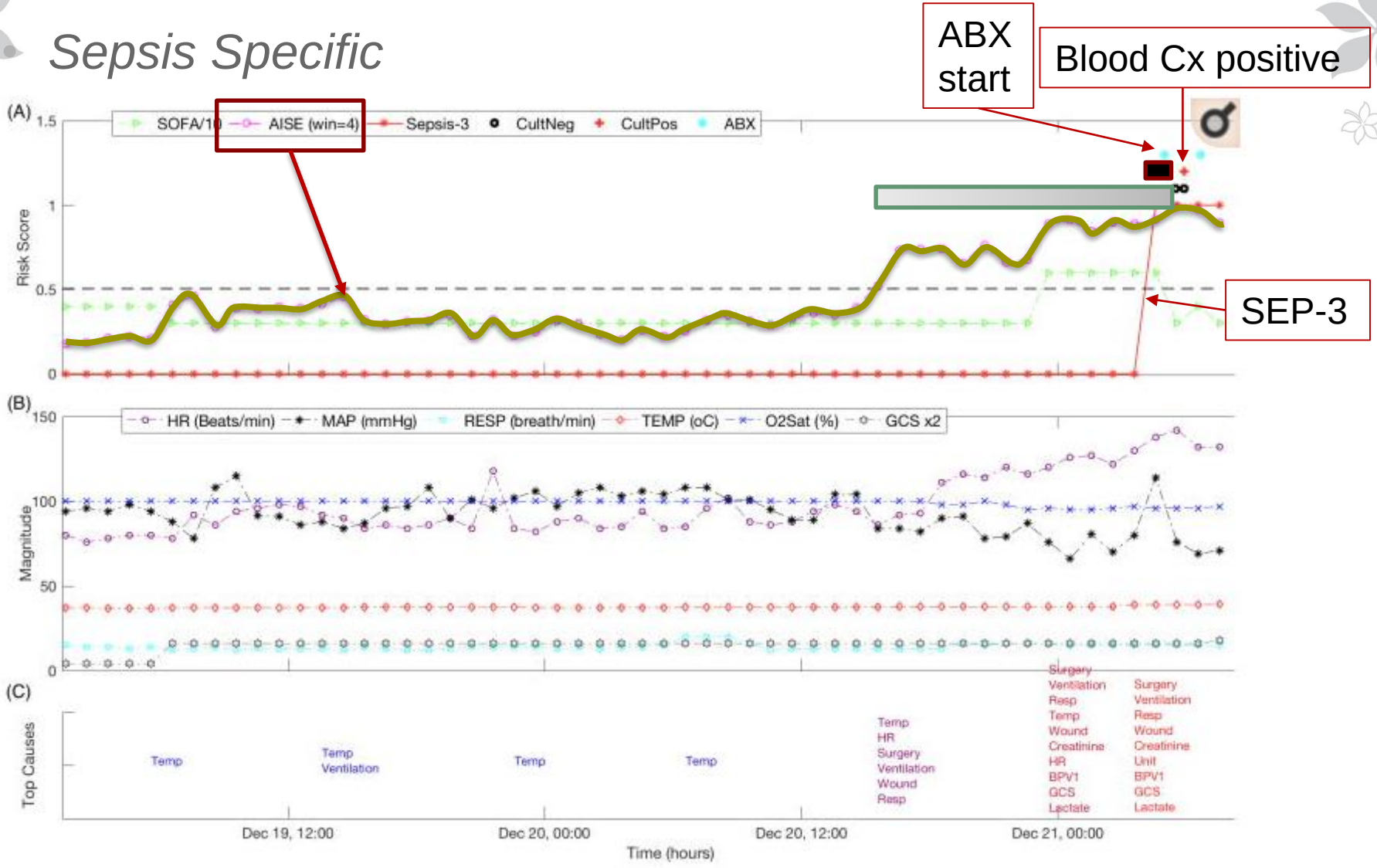
Laboratory (Arterial Blood Gas or ABG; 5 features): pH, pCO2, HCO3, Base Excess, SaO2.

Demographics/History/Context (19 features): Care Unit (Surgical, Cardiac Care, or Neurointensive care), Surgery in the past 12 hours, Wound Class (clean, contaminated, dirty, or infected), Surgical Specialty (Cardiovascular, Neuro, Ortho-Spine, Oncology, Urology, etc.), Number of antibiotics in the past 12, 24, and 48 hours, Age, Charleston Comorbidity Index (CCI), Mechanical Ventilation, maximum change in SOFA score over the past 6 hours.

Crit Care Med. 2018 Apr; 46(4): 547–553.

But what else is available for ERT/sepsis triggers?

Sepsis Specific



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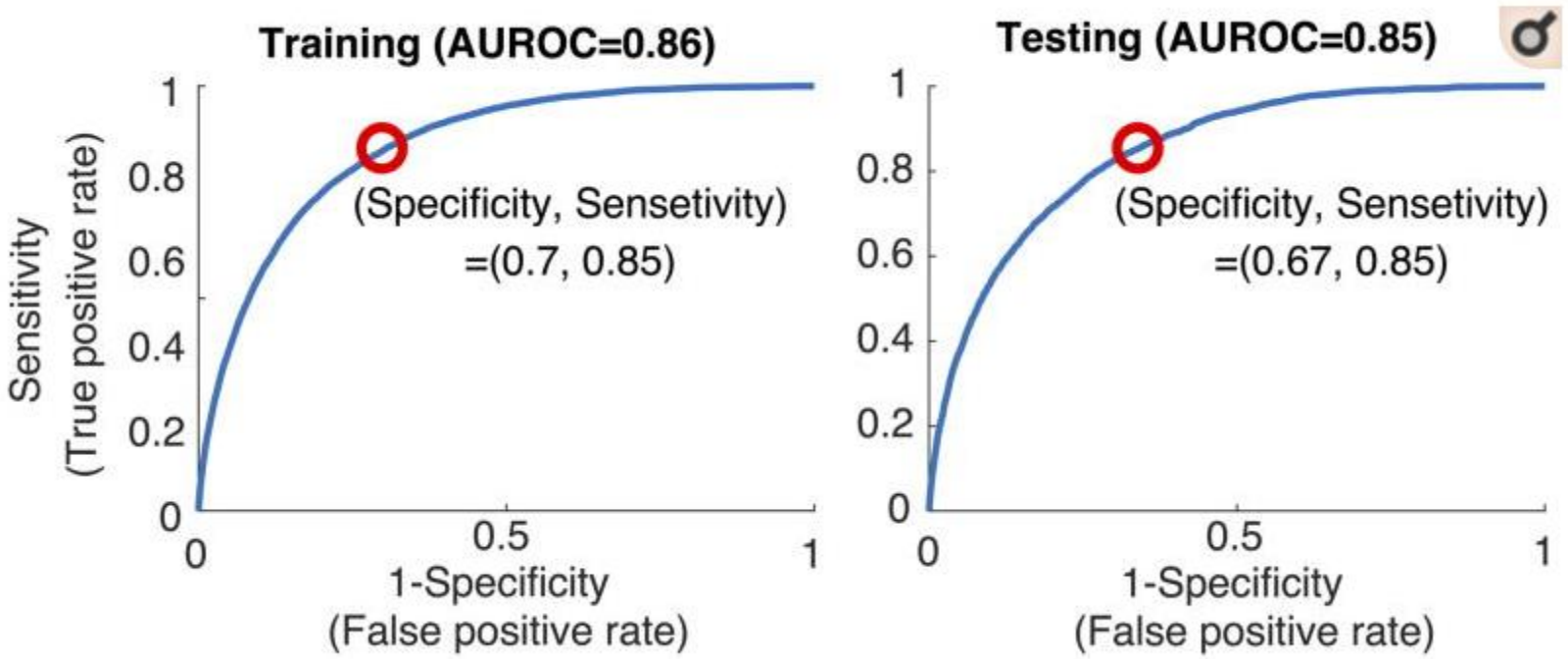
But what else is available for ERT/sepsis triggers?

Sepsis Specific



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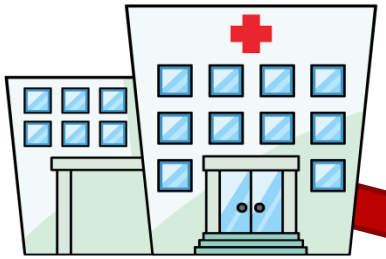
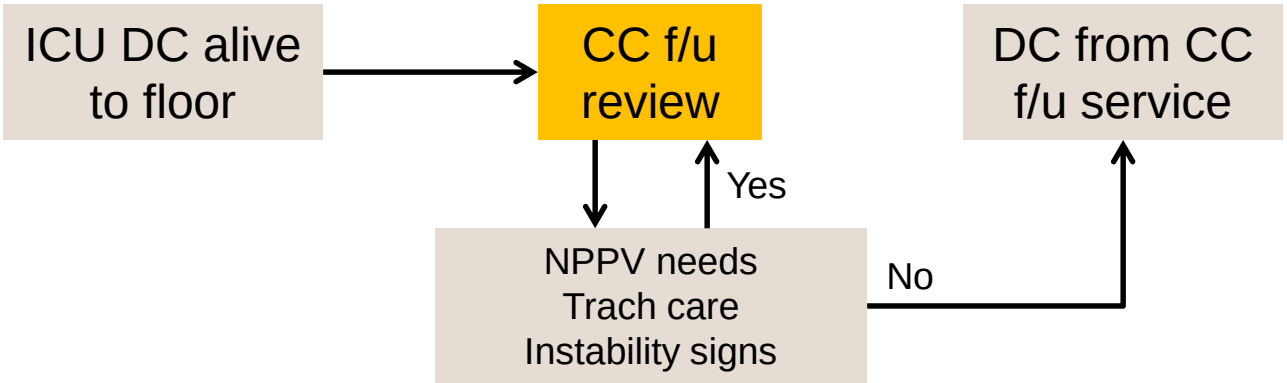
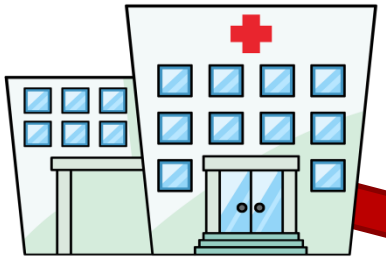


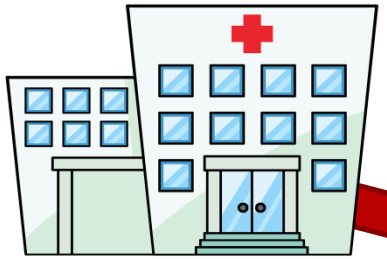
- Effect of Critical Care Outreach teams on survival and ICU readmission
  - Nurse led team, single UK hospital, Pre-post design
  - 12 hours per day
  - Daily follow-up





- Effect of Critical Care Outreach teams on survival and ICU readmission

	Proportion of interventions
Guide tracheostomy management	10.1%
Perform chest physiotherapy	8.7
Guide vent support	8.3
Patient re-position	7.9
Request medication	7.1
Request blood test	6.9
Increase monitoring	5.5
Measure I/O	3.6
Request micro testing	3.2

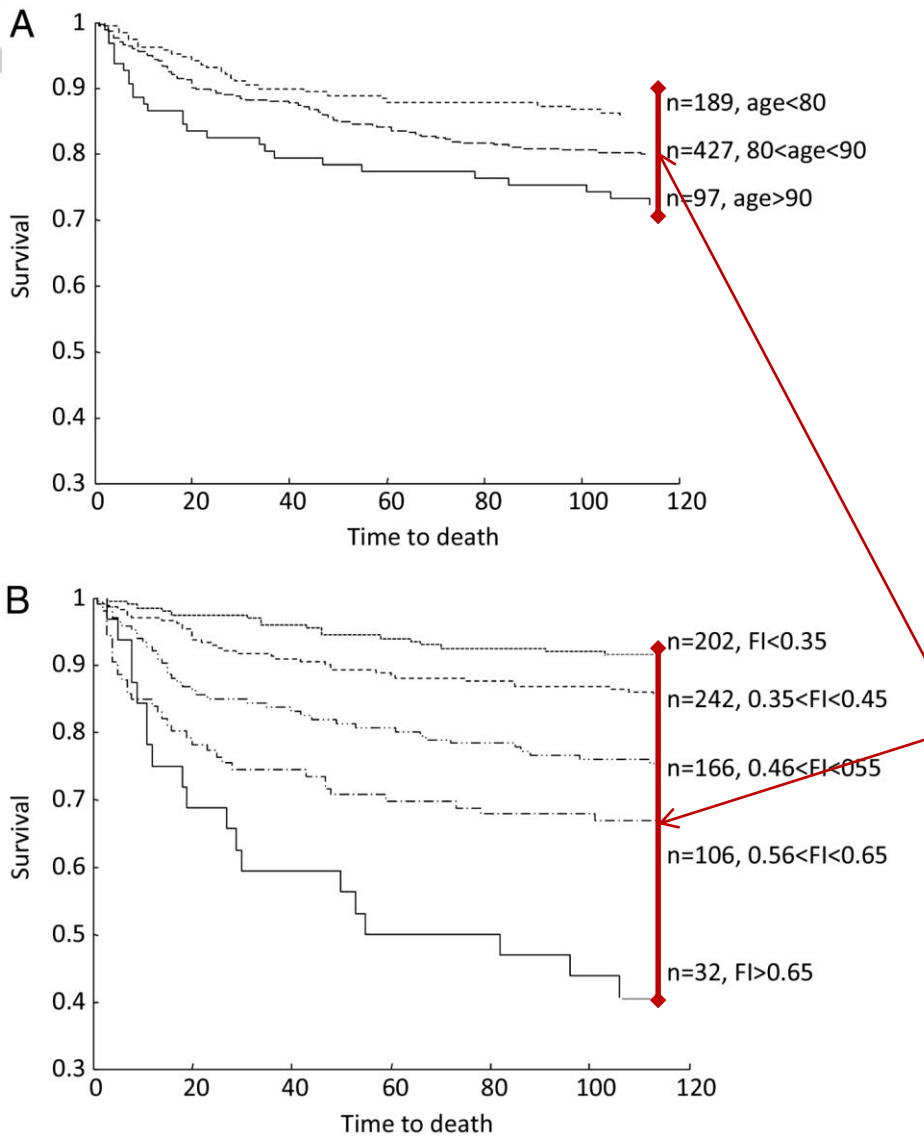


Should ***Critical Care specialists*** follow through recovery?

- Effect of Critical Care Outreach teams on survival and ICU readmission
  - Nurse led team, single UK hospital, Pre-post design
  - 12 hours per day
  - Daily follow-up
  - ***No difference in ICU LOS***

	Pre vs. Post	RR
Survival to Hospital DC	81% vs. 87%	1.08 (1.00-1.18)
ICU readmission	12% vs 6%	0.48 (0.26-0.87)

On which patients should we perform targeted assessments?



Elderly patients admitted to hospital were prospectively screened:

- individuals on inpatient medical units in a hospital,
- *n* = 752, aged 75+ years, were evaluated on hospital day 1

In an elderly patient group FRAILTY described a broader range of outcome than age alone

age and ageing

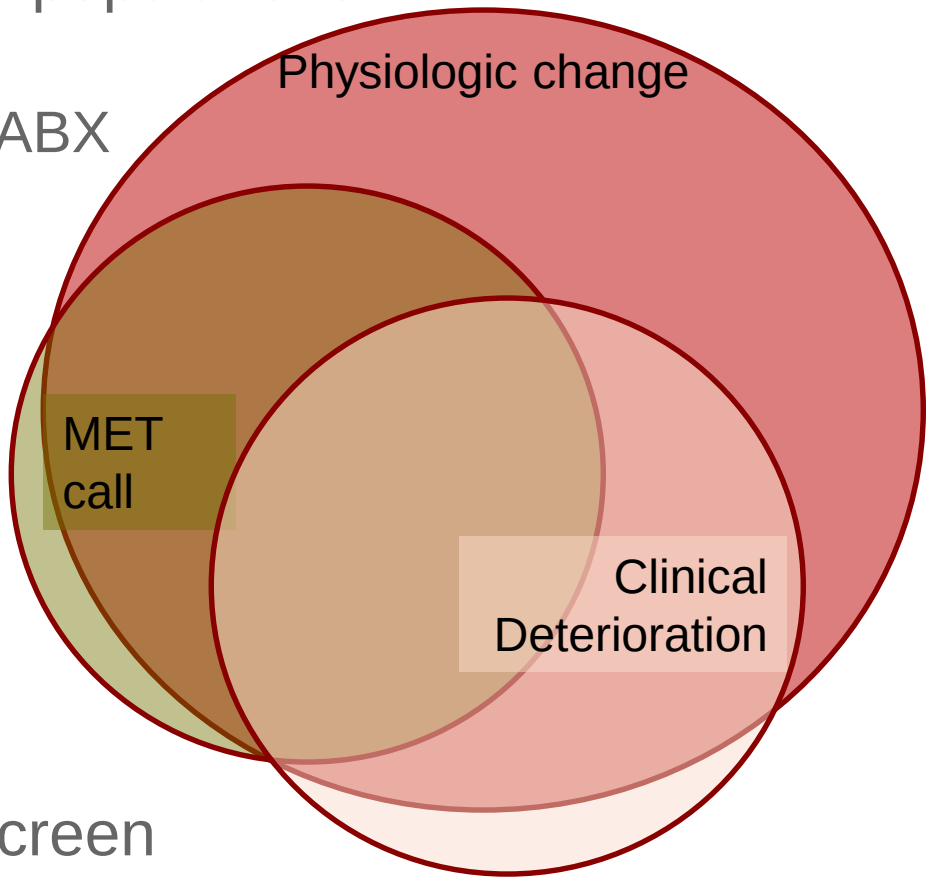
The Ohio State University
Wexner Medical Center

On which patients should we perform targeted assessments?– Medical Frailty

Variable	Response
Help bathing	Y/N
Help Dressing	Y/N
Help with chair	Y/N
Help Walking	Y/N
Help eating	Y/N
Self rating of health	1-4
Activity level	Various
HTN	Y/N
CHF, others	Y/N
Chronic lung disease	Y/N
BMI	--
Grip strength, shoulder strength, peak flow	various

Putting it all together

- Focus on the right patient populations
  - MEWS increase
  - ED admissions without ABX
  - Transfers from ICU
  - Post-op patients



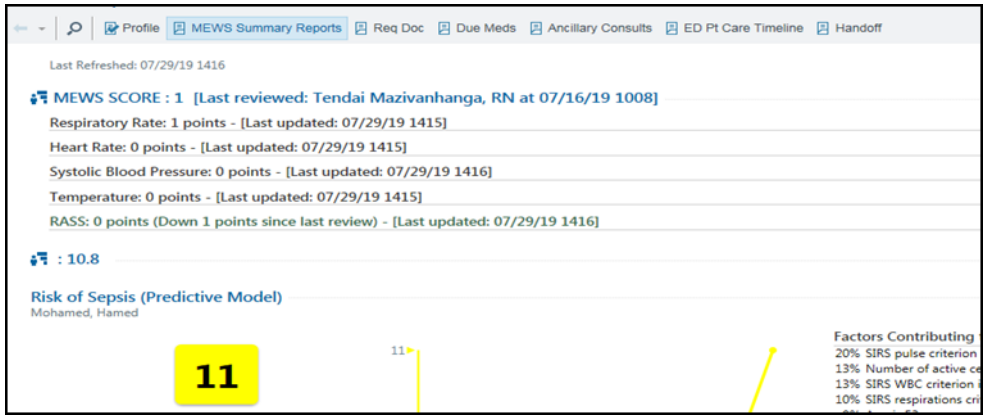
- Apply a Sepsis specific screen
  - Drive assessments to have informed escalations to the clinical team

Sepsis Risk Score from the EMR

Documentation	Medications	Lab Results	Comorbidities
Temperature (above 100.4, below 96.8)	Alpha/beta-blockers	WBC count (below 4 or above 12)	Coronary artery disease
Heart rate (above 90)	Analgesics/antipyretics	Banded neutrophils	Congestive heart failure
Respiration rate (above 20)	Analgesics/narcotics	Base excess, arterial	Chronic kidney disease
Pressure ulcers	Antianginals	Creatinine	Chronic liver disease
Central venous catheters - single lumen	Antiemetics/antivertigos	Hematocrit	COPD
Central venous catheters - triple lumen	Antifungals	Hemoglobin	Diabetes
Closed/suction drains	Antihypertensives	Hemoglobin A1c	HIV
Endotracheal tubes	Beta-blockers	Lymphocytes	Hypertension
Feeding tubes	Beta-blockers/glucocorticoids	Mean corpuscular hemoglobin concentration	Obesity
Incisions	Beta-lactam antibiotics	Monocytes	
Peripheral IVs	Cephalosporins	Neutrophils	
Peripherally inserted central catheters - double lumen	Electrolyte maintenance solutions	Nucleated red blood cell count	
Port-a-Caths	Fluoroquinolones	Platelet count	
Swan-Ganz catheters	Glucocorticoids	Procalcitonin	
Sex of 'Male'	Hypnotics	RBC count	
Ethnicity of 'Unknown'	Leukocyte stimulators	RBC morphology	
Marital status of 'Married'	Local anesthetics	Red blood cell distribution width	
	Loop diuretics	Reticulocytes	
	Penicillins	Segmented neutrophils	
	Proton pump inhibitors		
	Sodium/salines		
	Vancomycins		

Hands-on Education

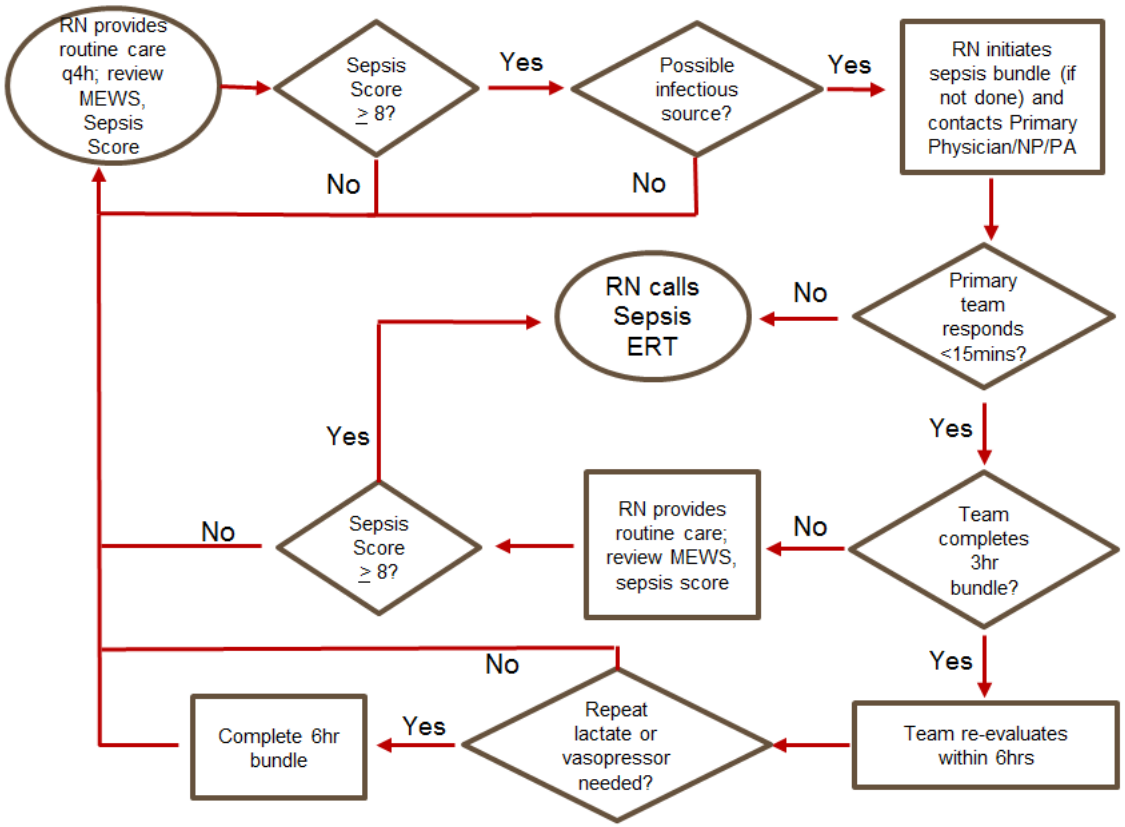
- **Activate and Assess**:
  - **You can wrench in Sepsis Risk (Predictive Score) Info, Sepsis Risk Communications, and Sepsis Bundle Status**
  - **You can also utilize the MEWS/Sepsis Risk Patient Mgmt report located at the bottom of you Patient List page.**



This tab includes all information related to sepsis, such as:

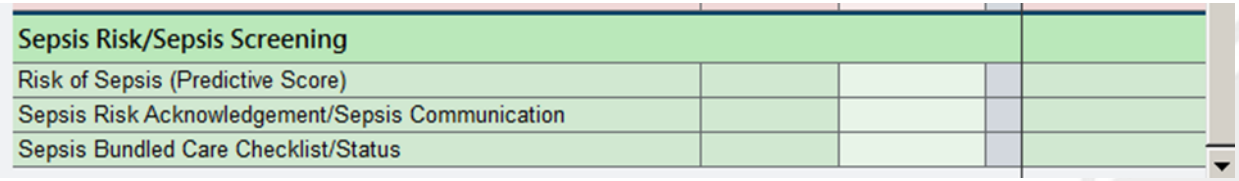
- MEWS and Sepsis Predictive Model
- Lactate and WBC trends
- Antibiotics
- Fluids
- VS trends

Bedside RN screening of MEWS + Sepsis Risk Score



Sepsis Risk/Sepsis Screening

- If you review a patient for potential sepsis, you will need to document your evaluation.
- In Flowsheet, open the tab “STAT RN (Mews/Sepsis) Response”
- At the bottom of this flowsheet is “Sepsis Risk/Sepsis Screening”



- The Predictive Score populates
- Sepsis Risk Acknowledgement/Sepsis Communication and Sepsis Bundled Care Checklist/Status has dropdown menus for each.

Conclusions

- Systematic screening is the most pragmatic way of screening and identifying “at-risk” sepsis patients
  - Specific variable << *integrated score*
- Target the right patients→ way to narrow trigger rate
- Understand your institutional trigger capacity
- Know your teams and what tools they need

- Monitor the case rate and the outcome

Thank You

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